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OIL & GAS ACTIVITY in the Northern Region

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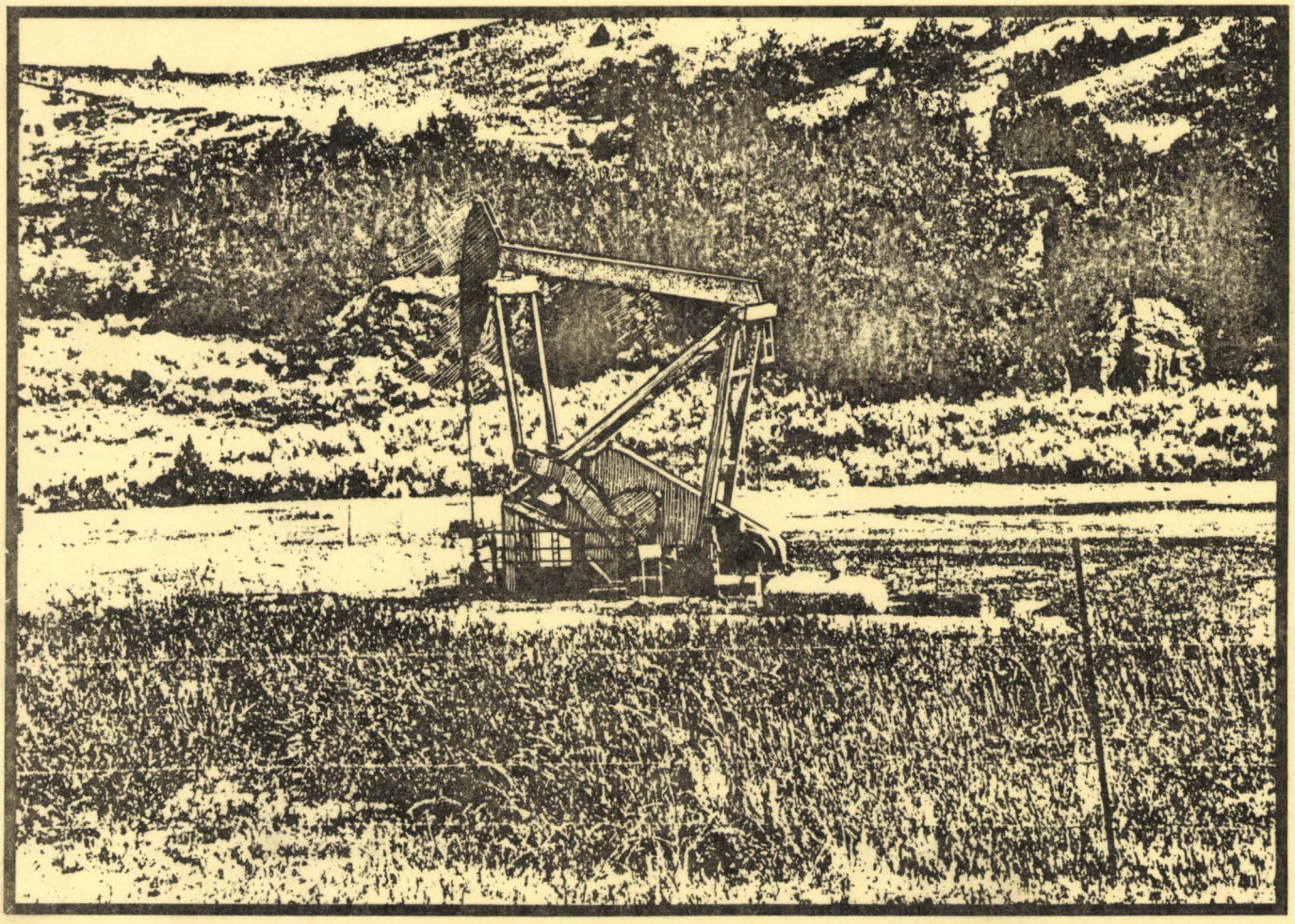

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OIL AND GAS ACTIVITY IN THE NORTHERN REGION

OVERVIEW

This document reviews selected social, legal, and practical aspects of oil and gas activities on National Forest lands. It discusses the U.S. energy crisis, emerging Federal energy policy, and the Forest Service role in both permitting and regulating oil and gas operations. It identifies prospective lease areas in the Northern Region, describes activities that might occur, and discusses some of the physical and social effects of petroleum exploration and development.

Prepared by the Minerals Impact Evaluation Group of the Forest Service, Northern Region's Minerals and Geology Staff Unit, this booklet is designed to help acquaint people with possible or impending effects from minerals activities on National Forest System lands.

Suggestions for the improvement of the document are welcomed.

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THE ENERGY CRISIS

During the past four decades, world energy consumption has increased dramatically. Most countries are now experiencing an energy crisis of a scale hitherto unknown. It has been brought on by a number of factors, including:

- Rapid population growth everywhere outside of Europe. Total world population has approximately doubled since 1930 and, at present rates, would double again within 40 years.

- Rising living standards. In both industrial and developing nations, rising consumer demands force per capita energy consumption upward at rates exceeding population growth.

- Early development and use of the most obvious and accessible energy sources, particularly hydropower and petroleum. Some major oil and gas reservoirs have already been depleted.

In the 1950-1970 period alone, U.S. energy consumption more than doubled, and the rate of consumption in industrially developing nations increased much faster (table 1). Most of the increased demand was for oil and gas.

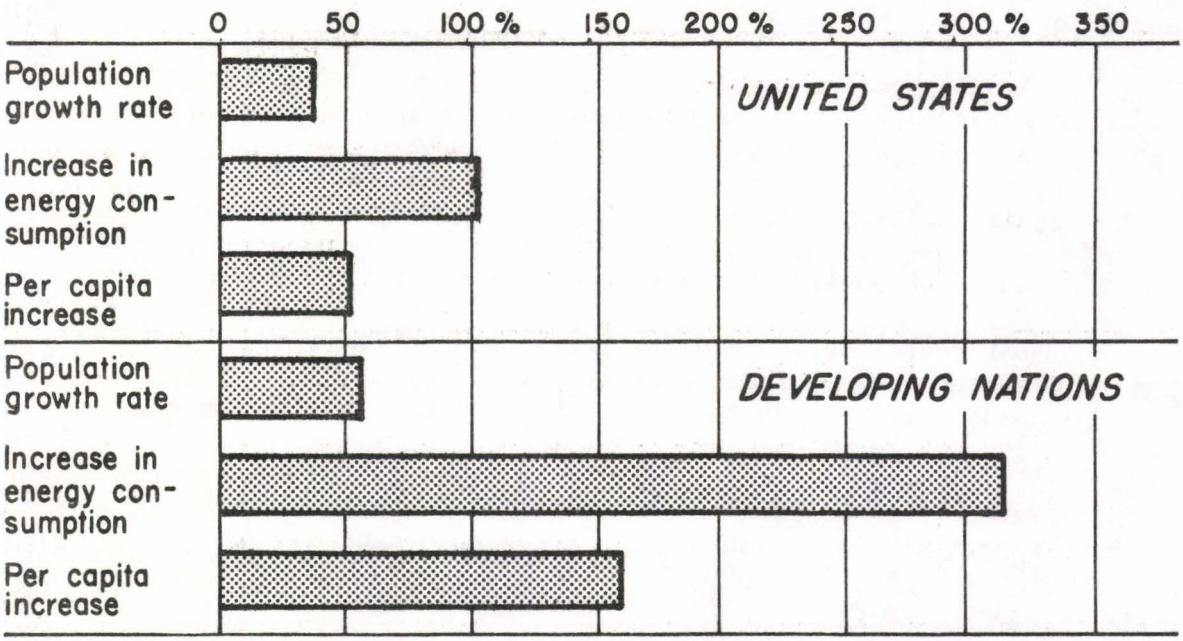
U.S. Dependence on Oil

Historically, the United States has enjoyed a very favorable ratio of natural resources to population. Together with a number of other social and geographic conditions encouraging resource development, this has permitted the world's highest material living standard. Essential to this standard have been abundant and reliable energy supplies: initially wood, water, and animal oils; later coal; and then oil, natural gas, and uranium. Wind and solar power have also been used on a smaller scale.

The invention of the automobile and the switch to oil and gas heating encouraged early identification and rapid development of this country's oil and gas resources. These fuels were cheap, efficient, and easy to transport. Coal production actually declined as more and more homes, schools, farms, and factories converted to petrofuels. By 1976, the energy derived from oil and gas was more than double that of all other recorded sources combined. U.S. per capita consumption of oil is today higher than any nation except Canada (table 2).

Table 1. HOW GROWING POPULATIONS AND RISING LIVING STANDARDS AFFECT WORLD ENERGY CONSUMPTION.

Note percentage increases between 1950 - 1970, both in the U.S. and in nations experiencing industrial development.



Sources: United Nations, World Bank, U.S. Census, and the World Energy Conference, London, 1977.

Table 2. PER CAPITA CONSUMPTION OF OIL (barrels)

	1973	1978	1973-78 trend	1979 trend
United States	26.3	30.8	up 17.1 %	down 2 %
Canada	26.6	29.5	up 10.9 %	up 5 %
West Germany	17.6	17.2	down 2.3 %	up 2 %
Japan	16.2	17.2	up 6.2 %	up 3 %
France	17.2	15.1	down 12.4 %	stable
United Kingdom	14.5	12.0	down 16.9 %	stable
Italy	12.6	12.5	down 0.8 %	up 4 %

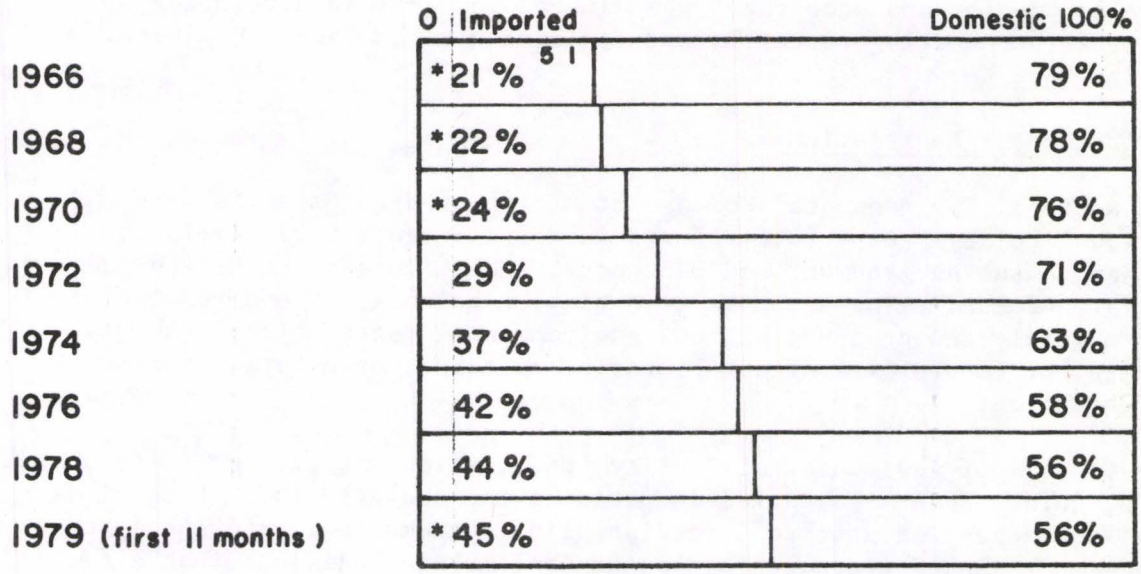
Major Sources: U.S. News and World Report, July 30, 1979
U.S. Department of Energy

Trends Since 1970

Since 1970, the oil and gas situation has changed abruptly. The 1973 Arab oil embargo and scattered U.S. fuel shortages underscored our growing dependence on foreign oil (table 3). At this time, most of the dozen or so nations with sufficient energy reserves for large-scale export formed a cartel (OPEC) 1/ to regulate production and pricing. A series of sharp price increases ensued and, during this decade, the price of a barrel of imported crude oil rose from less than $3 to an official price of $23.50 in November 1979.

Until the end of 1978, per capita U.S. oil consumption continued to rise faster than in most other industrial democracies (table 1). The U.S. is now the major net importer of petroleum and our dependence on foreign sources increases each year. In 1979, we imported almost half of the oil we consumed (table 3). During 1978 and 1979, U.S. gasoline and fuel oil prices almost doubled, increasing the public's incentive to conserve, and U.S. consumption now (1980) appears to be leveling off (table 2).

Table 3. THE GROWING U.S. RELIANCE ON IMPORTED OIL



Major Sources: U.S. News and World Report, July 30, 1979
DOE Monthly Energy Review, October 1979

*** Estimated from incomplete data.**

1/ OPEC (Oil Producing and Exporting Countries) in 1979 included, in order of volume of U.S. imports: Saudi Arabia, Nigeria, Libya, Venezuela, Algeria, Indonesia, United Arab Emirates, Iran, Kuwait, Qatar, Iraq, Ecuador, and Gabon. A third of our imports are from other countries, such as Canada, Virgin Islands, Mexico, Trinidad, and the Netherlands Antilles, but these prices tend to follow OPEC increases.

THE ROLE OF THE FOREST SERVICE

Two different categories of Federal (and complementary State) law define the Forest Service role. One, consisting of various mining laws, both permits and encourages oil, gas, and other minerals activities on public lands. Another, generally more recent set, environmental legislation requires that these activities be compatible with other resources and uses on these same lands.

Mining Law

The Mineral Leasing Act of 1920, as amended and supplemented, provides for private leasing of oil, gas, coal, oil shale, and a few other mineral options on public domain lands. This pertains to most National Forest holdings, including wildernesses (under the Wilderness Act of 1964) until 1984. Excluded are certain National Parks and monuments, military installations, administrative sites, and other areas designated by Congress. The Acquired Lands Act of 1947 extended this principle to additional lands not covered by the 1920 Act.

The Mining and Minerals Policy Act of 1970 reaffirmed the Federal commitment to "foster and encourage" the mineral industry in developing reserves, conducting research, and reclaiming mined land and mineral waste.

Environmental Legislation

The National Environmental Policy Act of 1969 (NEPA) establishes a national policy "to promote efforts which will prevent or eliminate damage to the environment and biosphere, and stimulate the health and welfare of man." The Act aims to achieve a balance between population and multiple resource use without environmental degradation, risks to health, or loss of "important historic, cultural, or natural aspects of our heritage."

The Council of Environmental Quality (CEQ), which was erected to regulate NEPA, guides Federal agencies in pursuing the above goals. It requires that such agencies utilize interdisciplinary teams to insure a comprehensive yet balanced approach to planning and making decisions that affect the human environment.

The National Environmental Quality Improvement Act of 1970 supplements NEPA. The act stresses the need to enhance environmental quality, and places this responsibility on Federal agencies and State and local governments. It establishes the Office of Environmental Quality to furnish support staff for CEQ, to assist in assessing programs affecting the environment, to coordinate agency activities, to promote environmental impact research, and to develop environmental quality standards.

The Wilderness Act of 1964 establishes a National Wilderness Preservation System to consist of Congressionally designated "wilderness areas," to insure that future generations would have access to places where "the earth and community of life are untrammeled by man, where man is himself a visitor and does not remain." In general, roads, motor vehicles, and permanent facilities are prohibited. Two exceptions allow some preexisting facilities to remain and permit mineral activity that is "carried on in a manner compatible with the preservation of the wilderness environment."

The Wild and Scenic Rivers Act of 1968 provides for preserving selected free-flowing rivers with "outstanding remarkable scenic, recreation, geologic, fish and wildlife, historic, cultural, or other similar values."

The National Historic Preservation Act of 1966 created the Council on Historic Preservation to review Federal activities affecting cultural and historic properties. It also authorized the development of a National Register of Historic Places, a listing of districts, sites, structures, and objects of significance in American history, archeology, architecture, and culture. The object is to identify cultural resources that should be protected and preserved whenever possible.

The Endangered Species Act of 1973 extended the Forest Service's responsibilities to protect and enhance habitats of endangered and threatened species. Any Federal agency must insure that any activities it authorizes, funds, or implements do not jeopardize the continued existence of such species or result in the destruction or modification of their habitat. 2/

Present Forest Service Direction

Present laws and directives require the Forest Service to permit legitimate energy development, while also providing optimal protection for other resources including wildlife, timber, soil, air, and water, and uses such as grazing, camping, hiking, hunting, and other mining.

As Federal employees, Forest Service personnel, while directed to follow National laws, policies, and regulations, must also be attentive to the concerns of local, Regional, and National publics, including a variety of special-interest groups. This especially includes communities and individuals who are directly affected by Forest programs. National Forest programs, to be successful, must reflect the needs and desires of the many who are concerned with their management.

2/ Portions of many of these laws are reprinted in The Principle Laws Relating to Forest Service Activities, USDA Handbook No. 453, Sept. 1978.

In general, present National direction requires multiple resource management for most lands. Priorities are occasionally assigned to one activity or another (as with endangered species), or because two or more simultaneous uses may not be practical.

The Task Ahead

With the increased seriousness of the energy situation, the Forest Service is faced with a deliberate Service-wide reorientation of its minerals program, especially for oil and gas and other leasable energy sources. The Chief of the Forest Service now requires action on lease applications within specified time limits, 2 months when the activity is covered by a land management plan or appropriate environmental document (EA/EIS); otherwise 1 year. It also calls for eliminating the present backlog of lease applications within 2 years and concurrence with operating plans within 1 month for routine exploration or operations which were considered in prelease environmental analyses. Lease applications are to be processed whether or not oil and gas activity has been addressed in land management plans. The Northern Region has fixed August 1, 1980, as the deadline for acting on existing applications in areas other than wilderness or other areas where the Chief has retained authority. All applications, including those in wilderness, will be evaluated by October 1981.

THE LEASING SITUATION IN THE NORTHERN REGION

Oil and gas exploration has been evident in one place or another in the Northern Region throughout this century. Large-scale production began to occur in both eastern Montana and western North Dakota in the late 1940's. It continued to increase until about 1968, then leveled off. Approximately 85 percent of this activity has occurred on private lands.

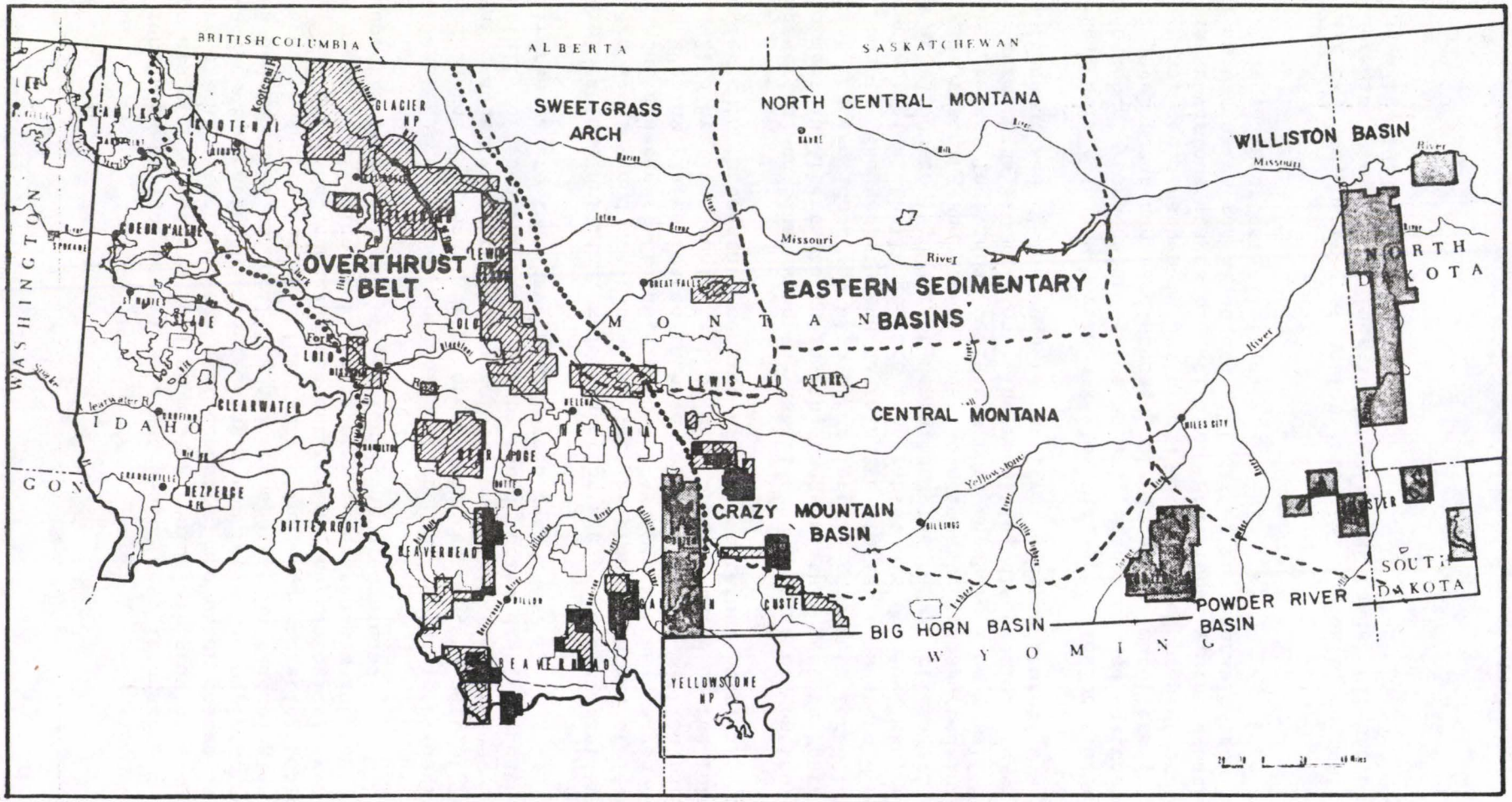
Oil production in Montana and North Dakota now totals about 55 million barrels annually, which is 1.6 percent of current National output and about double the amount of petroleum products consumed in the region. Natural gas production in the region is 0.4 percent of the National total. (See the Northern Region Oil and Gas Guide, chapter 1, for more details.)

Recent Trends

Oil and gas activity in the Northern Region is expanding in the Williston Basin east of the Montana-North Dakota border, and in the Montana Overthrust (also Disturbed) Belt which occupies much of the western portion of the State (figure 1). Most lease applications are for tracts in the Overthrust (table 4), which includes large acreages of National Forest and other public lands.

Figure 1

OIL AND GAS ACTIVITY



Situation in 1979

LEASES

APPLICATION FOR LEASES

With the recent sharp increases in oil and gas prices, it has become profitable to explore for oil in less promising geological provinces and in areas where climate, terrain, depth of deposits, and other obstacles have discouraged previous efforts. Increasingly sophisticated exploration techniques and improved oil drilling and transportation technologies have also enhanced prospects for locating, extracting, and marketing petroleum resources. In addition, changing conceptions of the geological events that have produced oil-rich rock strata have generated new interest in certain superficially explored or previously ignored areas.

Recent evidence suggests that more of western Montana than previously supposed is in the Overthrust Belt, created as the western part of North America was gradually compressed to help form the Rocky Mountains. If so, potentially oil-bearing rocks may be found buried deeply beneath older, oil-free layers that have been forced over them.

Already exploration, drilling, and production are proceeding rapidly in southwestern Wyoming and are expanding into neighboring areas of Idaho and Utah. One cluster of fields, including AMOCO's Whitney Canyon development in Wyoming, is estimated to have reserves of 600 million barrels of oil and 2.25 trillion cubic feet of gas, about a third of the total projected for this three-state section of the Overthrust Belt. 3/

These discoveries, combined with the established pattern of continuing oil development in Alberta to the north, suggests that western Montana and parts of eastern Idaho may also offer fertile prospects for oil and gas development. The geology and terrain are similar to western Wyoming and the technological challenges are comparable. In Wyoming, many of the wells are at 12,000 to 19,000 foot depth, and the heavy drilling rigs necessary for reaching such depths must sometimes be transported into very remote areas. Individual wells may cost anywhere from a half million to as much as $10 million. The resulting discoveries, however, have been frequent and rich enough to justify the expenditure.

If oil or gas exists in the Northern Region, its specific location and amount is unknown. Consequently, the social, economic, and environmental effects of development can be discussed only in approximate terms, suggesting what could happen in and around some unnamed present or future lease areas at various stages of activity. Additionally, the events following an extensive gas discovery will differ considerably from those resulting from an important oil find.

3/ Patrick Chow, Overthrust Action Brisk; Williston Close Contender, and Eight of Nine Overthrust Finds in AMOCO's UPRR Lands, Oil and Gas Journal, June 12, 1978, pp. 15-19.

Table 4: The number and location of oil and gas leases and lease applications in the Northern Region, September 1979.

	Leases	Lease Applications
Beaverhead NF	147	183
Custer NF	1,587	280
Deerlodge NF	20	77
Flathead NF		334
Gallatin NF	65	125
Helena NF		131
Kootenai NF		30
Lewis & Clark NF	17	228
Lolo NF		30
Regional Total	1,836	1,426
Number of Acres Involved	±2,200,000	±2,500,000

FOREST SERVICE RESPONSIBILITIES

Preliminary Exploration

Any person may enter most National Forest lands to explore for petroleum or other minerals. This might include visual examination of surface features and collection of rock or soil samples. If a significant surface disturbance is necessary, a prospecting permit is required for leasable minerals and may be obtained from the District Ranger or Forest Supervisor. Permits are normally required for geophysical exploration activities such as seismic surveys and test drilling operations. Figure 2 summarizes the process of permitting and supervising exploration activities that may occur on National Forest System lands.

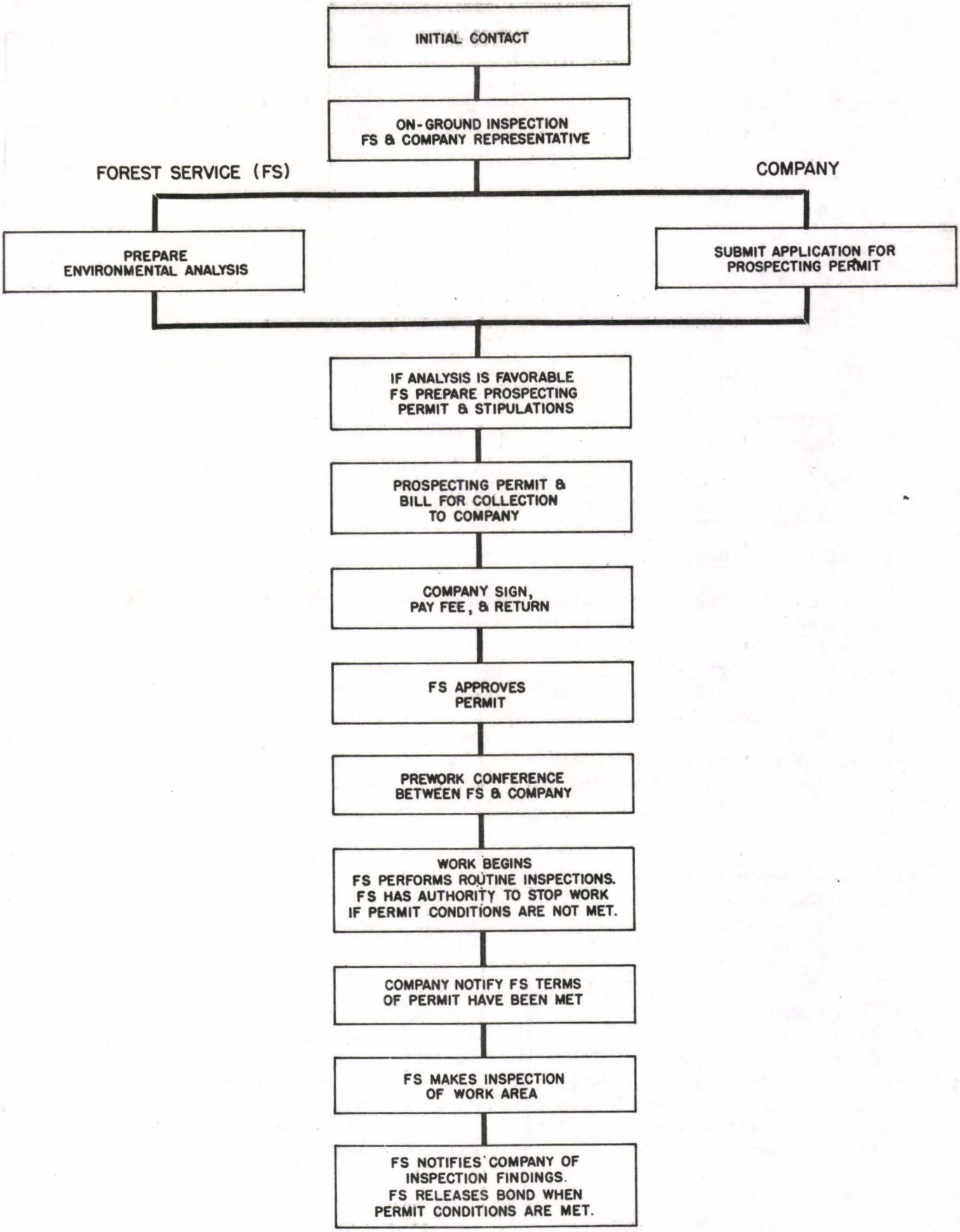
Leasing

If the presence of oil or gas is suspected and the area is available (that is, neither leased already nor withdrawn from leasing by Congress or administrative action), a lease may be obtained from the State Office of the Bureau of Land Management (BLM). Any U.S. citizen or domestic corporation may lease lands for oil and gas exploration and development.

If the U.S. Geological Survey (GS) has formally identified the area as "presumptively productive," that is, as a known geologic structure (KGS) with oil or gas potential, leases are competitive, limited to 640 acres, and sold to the highest bidder. Otherwise, one or more tracts (leaseholds) of up to 2,560 acres may be rented at $1 per acre annually for up to 10 years. There is also a $10 filing fee. Royalties are also collected if oil or gas is produced (see "Economic Effects" section).

Figure 2

GEOPHYSICAL PROSPECTING PERMIT PROCESSING



Before issuing leases for National Forest lands, the BLM sends applications to the Forest Service for review. By interdepartmental agreement between the Departments of Agriculture and Interior, the Forest Service now assesses possible effects of oil and gas activity on other resources and makes recommendations concerning leasing. The approved method for processing lease applications is shown in figure 3.

An important function of this process is to identify the need for surface protection measures or "stipulations." There are "standard stips," attached to all leases, and "special stips" that apply to unique situations. Stipulations may limit operations to certain seasons or exclude some types of terrain, wildlife habitats, stream channels, scenic vistas, cultural sites, or areas near Forest or community facilities. They may prohibit certain types of equipment, restrict road building or use, or include measures that prevent stream pollution. They may even require neat, appropriately fenced, and painted site facilities. When carefully selected and enforced, lease stipulations are effective tools for protecting the environment while allowing full enjoyment of the leasehold. Additional operating costs can usually be held to a minimum by careful planning and execution of operating procedures.

Oil and Gas Operations

Once a lease is issued, the U.S. Geologic Survey (GS) supervises onsite oil and gas operations such as drilling and production. However, through a cooperative agreement between the GS and FS, the Forest Service provides surface resource information to the GS for planning and administration purposes. The Forest Service also retains administrative authority in cases involving emergency situations endangering health, safety, and other resources. Table 5 summarizes the roles of the agencies and lessees in oil and gas operations.

Figure 3

PROCESSING LEASE APPLICATIONS

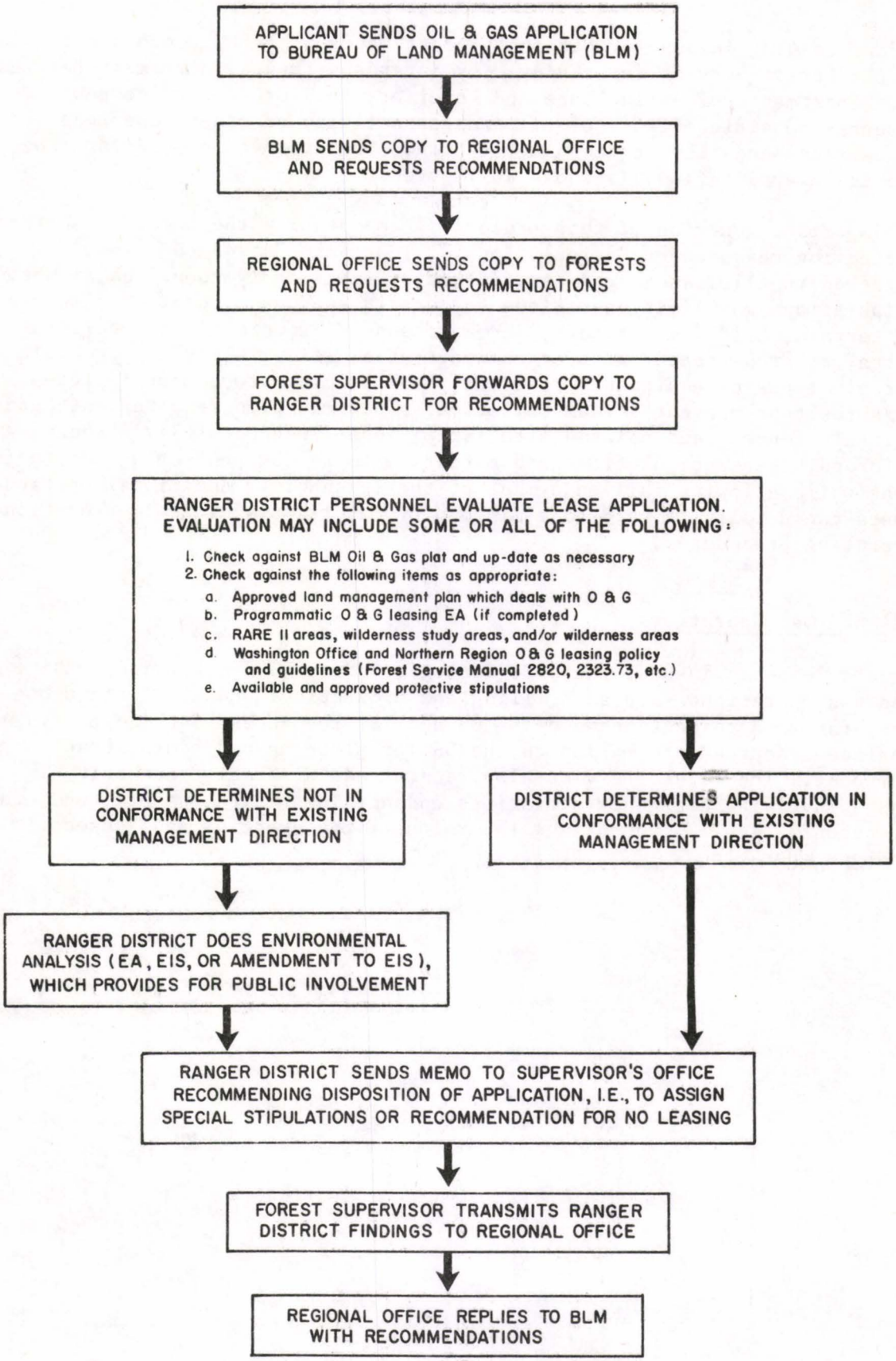

APPLICANT SENDS OIL & GAS APPLICATION TO BUREAU OF LAND MANAGEMENT (BLM)
BLM SENDS COPY TO REGIONAL OFFICE AND REQUESTS RECOMMENDATIONS
REGIONAL OFFICE SENDS COPY TO FORESTS AND REQUESTS RECOMMENDATIONS
FOREST SUPERVISOR FORWARDS COPY TO RANGER DISTRICT FOR RECOMMENDATIONS
RANGER DISTRICT PERSONNEL EVALUATE LEASE APPLICATION. EVALUATION MAY INCLUDE SOME OR ALL OF THE FOLLOWING:
1. Check against BLM Oil & Gas plat and up-date as necessary
2. Check against the following items as appropriate:
a. Approved land management plan which deals with O & G
b. Programmatic O & G leasing EA (if completed)
c. RARE II areas, wilderness study areas, and/or wilderness areas
d. Washington Office and Northern Region O & G leasing policy and guidelines (Forest Service Manual 2820, 2323.73, etc.)
e. Available and approved protective stipulations
DISTRICT DETERMINES NOT IN CONFORMANCE WITH EXISTING MANAGEMENT DIRECTION
DISTRICT DETERMINES APPLICATION IN CONFORMANCE WITH EXISTING MANAGEMENT DIRECTION
RANGER DISTRICT DOES ENVIRONMENTAL ANALYSIS (EA, EIS, OR AMENDMENT TO EIS), WHICH PROVIDES FOR PUBLIC INVOLVEMENT
RANGER DISTRICT SENDS MEMO TO SUPERVISOR'S OFFICE RECOMMENDING DISPOSITION OF APPLICATION, I.E., TO ASSIGN SPECIAL STIPULATIONS OR RECOMMENDATION FOR NO LEASING
FOREST SUPERVISOR TRANSMITS RANGER DISTRICT FINDINGS TO REGIONAL OFFICE
REGIONAL OFFICE REPLIES TO BLM WITH RECOMMENDATIONS

Table 5. THE ROLES OF AGENCIES AND LESSEES IN ON-SITE OIL AND GAS OPERATIONS

NOTE: Necessary steps are arranged in sequence from left to right

ROLE OF LESSEE	ROLE OF BUREAU OF LAND MANAGEMENT (BLM) AND GEOLOGICAL SURVEY (GS)	ROLE OF FOREST SERVICE (FS)	COMMENTS
Lessee (or his operator) submits to GS notice of intent to enter leased lands indicating location and type of activity proposed.	GS notifies FS of lessee's intentions, and requests FS concurrence.	FS reviews proposed plans and indicates through an environmental analysis: (1) There are no objections to entry onto the lands, or (2) environmental or resource conflicts exist which need to be resolved.	If FS analysis indicates conflicts, a joint conference or field review by affected parties is scheduled by GS to resolve the conflicts.
When conflicts have been resolved, lessee surveys and stakes proposed developments and submits to GS an application for permit to drill (APD) and Multipoint Surface Use and Operations Plan (OP) as prescribed in Notice to Lessee's No. 6 (NTL-6).	GS forwards APD/OP to FS and schedules a field meeting for lessee/FS/GS and other affected parties if a meeting has not been held previously.	FS does a site specific environmental analysis of the proposed activity to insure conformity of proposal with environmental values and management direction. Surface reclamation requirements will be identified at this time. FS responds to GS (1) consenting with the proposal, or (2) recommending changes or stipulations to protect identified surface resource values and uses.	If the FS analysis indicates a potential to affect cultural, archeological, or threatened and endangered species values, clearances must be obtained prior to forwarding recommendations to GS.
	GS makes an environmental analysis of the APD/OP which considers FS recommendations. If analysis is favorable, GS will approve plan in accordance with (1) lease stipulations, (2) oil and gas operating regulations (30 CFR 1/ 221), and (3) NTL 2/-6. If analysis is unfavorable, GS in consultation with FS will approve plan contingent on modifications, amendments, or stipulations adequate to protect surface resources.		
	Following notice of GS approval, BLM sets performance bond.		
When GS approval is obtained and bonding is accomplished, lessee conducts activities as prescribed on APD/OP.	GS administers all oil and gas field operations within areas of surface use (ASU) under authority of GS Oil and Gas Operating Regulations.	FS performs routine inspections for activities on the lease. Under direction prescribed in FS/GS Cooperative Agreement, FS can act directly in emergency situations to protect surface within ASU, but routinely goes through GS.	If additional activities on plan revisions requiring surface disturbance are desired by the lessee, decisions to allow such activities will be based on an environmental review process similar to that described previously.
Upon completion of his activities, lessee is required to submit to GS a notice indicating his intention to abandon operations.	GS sends a copy of notice of abandonment to FS.	FS performs inspection of the ASU and responds to GS indicating actions needed to comply with reclamation needs identified in APD/OP.	If additional work is needed to achieve acceptable reclamation, FS will work with GS and lessee to insure that proper reclamation is achieved.
		Following acceptable reclamation, FS consents to GS on abandonment and bond release.	
	GS recommends to BLM to release bond.		
	BLM releases bond.		

1/ CFR - Code of Federal Regulations
2/ NTL - Notice to Lessees

A SCENARIO OF OIL AND GAS ACTIVITIES

Successful exploration and development of oil and/or natural gas ordinarily involves a series of activities, some of which may occur simultaneously. 4/

1. Preliminary exploration, both before and after leasing. This may include surface geologic mapping, seismic activities, etc.

2. Exploratory drilling, including test holes for more specific information about subsurface geological features or "wildcat" wells to determine if oil actually exists in the more promising locations.

3. Field development, following a discovery, results from drilling additional wells and constructing necessary site facilities.

4. Producing, processing, and transporting petroleum products to refineries or markets.

5. Abandonment and appropriate reclamation of the depleted wells or fields.

Oil activity is highly speculative and seldom proceeds beyond stage one or two in any specified lease area. 5/ Compared to other types of mineral development, it normally involves rather few employees, can be operated profitably on a small scale, and, if properly conducted, will have only minor social and environmental effects. But a major oil find or a combination of small discoveries can significantly affect the social and economic life of an area.

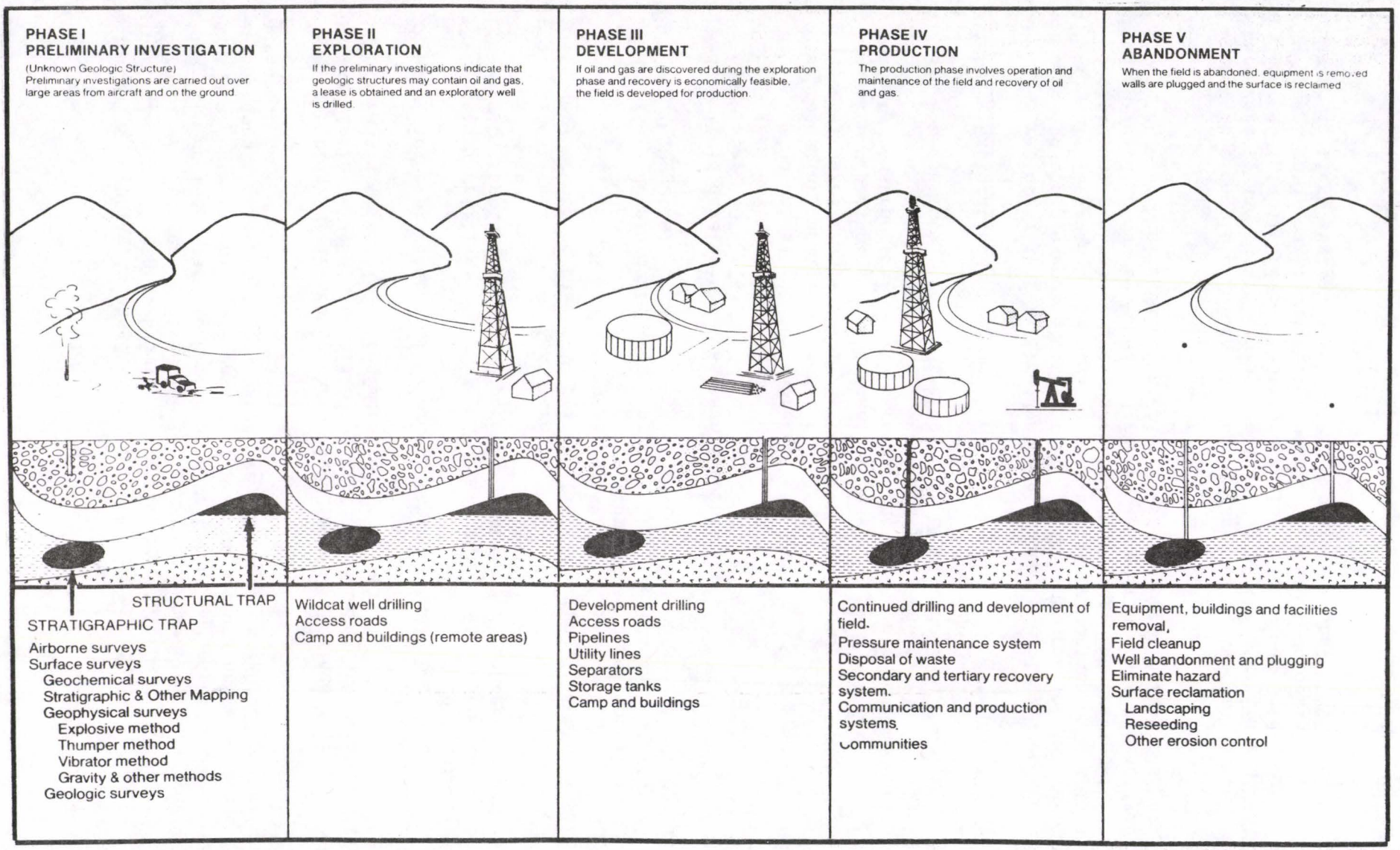
Each location has its own unique mix of oil potential, climate, terrain, available workers with appropriate skills, prevailing wage rates, community standards and controls, attitudes toward change, and ability to solve problems. All must be taken into account when predicting outcomes of oil activity. Thus the events portrayed in this scenario may differ substantially from what actually occurs in any specific region.

4/ For more detail about the technical aspects of oil and gas development, see A Primer of Oil Well Drilling, 3rd Ed. Austin: The University of Texas Petroleum Extension Service, 1970, available at USDA-FS Northern Region offices as an appendix to the Northern Region Oil and Gas Guide.

5/ Prior experience Nationally indicates that the probability of occurrence for a particular oil and gas activity sharply diminishes with each step in the process, since most areas explored yield neither oil nor gas.

Figure 4

SEQUENCE OF OIL AND GAS OPERATIONS



SOURCE: U.S. Department of Interior, Bureau of Land Management, 1972. Preliminary draft, Upland Oil & Gas Leasing Programmatic Environmental Impact Statement.

The following scenario is based on the past experience of oil-producing regions of eastern Montana, Wyoming, North Dakota, Colorado, and California. 6/ Inferences have also been made from numerous case studies dealing with coal and hard-rock mineral development and pipeline construction, the effects of which are easier to predict because answers to the essential questions of when, how extensive, and where are usually available in advance.

For a single block of leases (perhaps 25,000 acres) obtained in order to explore a single "play" (a promising geologic structure), the probability of each potential event is approximately as follows:

Preliminary exploration:	100 percent	(this probably has already occurred, prior to leasing)
Exploratory drilling:		(further preliminary exploration may discourage such activity)
a. stratigraphic test hole	50 percent	
b. wildcat well	25 percent	
Discovery of oil or gas:	10 percent	(in some cases, quantities will be insufficient to justify commercial development)
Small field development, (e.g., 10 wells):	1 or 2 percent	(but the success rate is currently higher in E. Montana and W. North Dakota)
Medium field development (e.g., 50 wells):	less than 1 percent	
Large field development, (e.g., 100 wells)	0.1 percent	
Gas processing facility	1 percent	
Construction of transmission pipeline:	1 percent or less	
Refinery construction:	0.05 percent	(the Region already has surplus refinery capacity)
Field abandonment:	100 percent, if developed	

Preliminary Exploration

After first reviewing what is already known about the geology, and from other clues to the presence of oil and/or gas in some areas of interest, oil firm geologists visit the area to seek additional evidence. Exploration concepts and technology are constantly improving, and previously overlooked features may be noted and mapped. Resulting data are analyzed, and a working hypothesis (called a "play") is developed. If it has not

6/ For more complete information on oil and gas activities in the Northern Region, see the following publications of the Minerals and Geology Group in the Regional Office: Northern Region Oil and Gas Guide, especially chapters 3 and 4; and Socioeconomic Assessment Guidelines for Oil and Gas Activities, available at USDA-FS Ranger Stations.

already done so, the company then attempts to lease the most promising sites, either to conduct more intensive exploration or to be in a competitive position if another company discovers oil or gas in an adjacent area during the 10-year duration of the standard lease. According to one estimate, drilling has occurred on only 5 percent of the Federal leases in Montana.

More intensive exploration, when undertaken, usually involves seismic crews of 15-30 persons transporting their equipment by means of trucks or helicopter, depending on terrain. Among other things, the crew will try to locate the depth and angle of possible oil-bearing formations by recording the pattern of subsurface vibrations produced by a variety of techniques, including explosives placed in shallow (2 to 200 feet) drill holes or by dropping a truck-mounted, 3-ton steel plate several feet to the ground. As far as possible, existing roads are used and attempts are made to minimize environmental disturbances.

Newer technologies tend to be less disturbing. One newer technique is to mount explosives about 2 feet above the ground. The energy is thus dissipated in all directions, resulting in minimal damage even to nearby vegetation. Because they cause little surface damage, vibroseis trucks and tractors are now receiving wider use. They produce shock waves merely by vibrating a heavy weight pressed firmly against the earth.

The magnetometer, resembling a large camera, measures changes in the earth's magnetic field due to magnetic properties of subsurface rocks. A gravity meter survey gives information about hidden formations by measuring surface features or to record the strength and direction of magnetic forces emanating from the earth below.

If exploration activity expands sufficiently, a support unit of several persons may be stationed in the area to assist in supplying field personnel and in processing their findings. Many months may be required to examine a large lease area, and local residents will hear the sounds and witness various aspects of the activities.

Exploratory Drilling

When favorable sites have been pinpointed, truck-mounted drilling rigs may be brought in to drill test holes, sometimes thousands of feet deep. Surface disturbance from such equipment is minor unless new roads are required for their use on steep slopes. Subsurface rock is extracted and analyzed. Positive results require further high-level deliberation and the decision to allocate funds for a "wildcat" well may follow. In western Montana, this requires a very large rig with a crew of 20 or more. Approximately 2 to 4 acres are required to set up a drilling rig complete with pumps, tanks, and mud pit. Temporary access roads for transporting equipment and personnel may also be required. Energy requirements for drilling would be furnished by gas or diesel-driven equipment. In remote areas, well drilling may require the construction of temporary camps for workers or helipads in lieu of all-weather roads.

Almost all drilling is done by independent drilling contractors, and it is an expensive process. In 1978 in the Wyoming Thrust Belt, drill rigs rented at $4,500 daily for 7,000-foot wells, and at $7,500 for 20,000-foot wells. Simply moving a rig from one site to another within a field costs about $35,000. 7/ Crewmembers usually work in shifts around the clock, since up to 6 months or more may be required to drill through 1-4 miles of surface rocks to reach potentially oil-bearing formations.

Even with all of this sophisticated technology, oil reservoirs can be elusive. In the San Emidio area of south central California, for example, geologists and geophysicists, using a variety of techniques, spent 24 years in a futile search for oil, motivated by their faith that the geologic structure of the area was extremely favorable. A total of 26 exploratory wells were drilled without results. The resulting body of evidence permitted reinterpretation of the data, and new drill sites were established. Three fields were eventually developed and, in the last one in 1975-78, 47 of 50 wells drilled were successful. 8/

Historically, 1 wildcat well in 16 yields a significant amount of oil or gas but only 1 in 140 is financially profitable. 9/ In 1977 in Montana, 1 in 4 proved to be "successful," a category denoting significant but not necessarily profitable production. New technology, both in instrumentation and data interpretation, have substantially increased the odds that an exploratory well will also be a production well.

Field Development and Production

If exploration results in the discovery of an oil and gas reservoir, additional rigs may be obtained; and drilling activity could continue for years until the boundaries of the field area are established. To maximize total field production, modern wells are generally spaced on plots ranging from one oil well for every 40-320 acres to one gas well for every 160-640 acres of a field. 10/

Oil field development normally involves building all-weather road systems to oil wells for hauling out oil and maintaining operations. It includes installing pumps and gathering pipelines, erecting tank batteries, and sometimes constructing facilities for separating oil from gas and water. For larger fields, developments may include pipeline transmission systems to transport oil off the lease or field. Fields may also require aerial or underground utility lines to provide electrical power for site facilities, and underground pipelines and injection wells to dispose of water that was separated from the oil.

7/ Petroleum Information Corporation. The Overthrust Belt, 1978.

8/ See Taylor, Don S., California's Yowlumne Field--from Basics, IN Oil and Gas Journal, March 20, 1978, pp. 192-200.

9/ BLM, Montana State Office (Billings). Proposed Action, Oil and Gas Program EAR, 1979.

10/ For a more detailed account of oil drilling, see A Primer of Oilwell Drilling, 3rd Ed., op. cit.

Natural gas fields have significantly less environmental impact because of much wider spacing of wells and equipment and fewer roads. Pipelines from these fields are constructed only when sufficient production has been established. Gas wells normally flow without assistance, so pumps and motors are not required. If the gas contains large quantities of hydrogen sulfide, a dangerous gas, a facility is constructed for removing and flaring (burning) this. If natural gas exists only in small quantities, it is either used locally as fuel, or the well is simply capped until enough other area discoveries have provided sufficient gas to justify commercial development. Small amounts of gas removed from oil may be flared or reinjected into the reservoir to maintain pressure.

As each well is completed, rigs are dismantled and transported to another well site. Pumps (electrically powered, when feasible) are installed when needed, pits are filled, tanks and gathering line are constructed, and the drill site surface is reclaimed. A small maintenance crew and oil truck drivers or transmission pipeline workers eventually replace the one or more drilling crews and their support personnel, but years may be required to develop a large field, which will then continue to produce for another 20 years or more.

Significant field developments can incur some off-site effects, the extent of which would depend on the size of the field or operation. Most fields are in the 1,000 to 10,000 acre category, but a few rich fields have encompassed a township or more and contained 500 or more wells. 11/ The major surface impacts would be (1) construction or reconstruction of transportation facilities to link the area of operations with existing road systems; (2) development of oil and gas pipelines from the producing field to markets or existing pipeline systems; (3) construction of electrical powerlines from existing facilities to the oil field; and (4) the construction of necessary petroleum processing facilities. If enough natural gas exists to economically process it for marketing, a plant may be built to remove methane, gasoline, butane, and propane. If sour gas is encountered, facilities are needed to remove hydrogen sulfide. Such developments are normally constructed near the producing area, the number ranging from one to several, depending on the size of the field and the needs of the gas-producing company.

Since Montana's present refineries are already importing much of their (1977) supply of crude oil, a new refinery may be unnecessary. Construction of even a small refinery is a major undertaking involving hundreds of construction workers for perhaps 2 years. Following this, another 200 or more employees will be required to operate the facility. The current trend is toward larger, fewer refineries with less employees per unit produced.

11/ Estimate based on the Grass Creek, Wyoming, experience. See Grass Creek EAR, BLM, Worland District, Wyoming, 1978.

Abandonment and Reclamation

Reclamation procedures occur after each stage of activity. Reclamation includes either (1) returning well sites and roads to their approximate original contour and revegetation, or (2) converting the site to some new and useful purpose. It ideally involves safeguards against erosion, destroying scenic values, and pollution of local water sources. Its cost and complexity varies greatly with the stage and scope of the petroleum operation.

Reclamation after geophysical exploration is relatively simple. Roadways, if constructed for exploration purposes, are reclaimed if no further use is intended. Vibroseis or thumper trucks will trample the grass, but usually do not disturb the soil if wet seasons are avoided. Drill holes for seismic tests must be filled, along with any craters that may result. Normally, explosive holes are less than 4 inches in diameter; craters seldom exceed a foot or two in diameter. If fresh water aquifers are encountered, they must be sealed off immediately, above and below, to prevent contamination by impurities seeping in from other levels. Bentonite clay (which expands when wet) may be used to fill the hole, which is then capped with topsoil and seeded with a native grass mixture. All supply containers and marker flags are removed.

Well sites, roads, and pipelines in construction areas require the use of bulldozers and graders to reshape the landscape. Some oil firms now routinely begin landscaping as soon as each drill rig is removed, hence simplifying subsequent reclamation procedures. Drill rigs, tanks, sheds, and other equipment used in drilling are first removed and the mud pit is pumped as dry as possible, then filled with earth originally excavated and stockpiled near the site. Topsoil is spread and landscaping completed. Production pumps and tanks are skillfully blended into the surroundings, protective dikes and fences are neatly constructed and regularly maintained, and shrubs and grasses are planted.

Oil and gas activities on National Forest System lands may affect other (surface) resources and uses, both directly and indirectly. Most of these effects can be mitigated through project adjustments, stipulations on use, permit requirements, etc., so the activities can be compatible. If resource conflicts cannot be mitigated or resolved, the trade offs will have to be evaluated and decisions made to allow or disallow the activity.

There are a number of potential conflict areas. Wildlife and fisheries habitat management may conflict with petroleum exploration and development on approximately 25 percent of the region's land base. Threatened and endangered species habitat has been identified on many of the National Forest areas under oil and gas lease applications. This, along with seasonal habitat requirements of various species, presents one of the major areas of potential conflict with energy-related activities.

Other major areas of potential conflict with oil and gas activities include visual resources, cultural resources, water quality, clean air, range use, dispersed recreation, and wilderness. Important concerns include possible oil spills from drilling operations or pipelines, dust resulting from site preparation and increased travel, and the noise level of drilling, trucks, helicopters, and explosives.

SOCIAL AND ECONOMIC IMPLICATIONS

The social and economic consequences of oil and gas activity are highly variable, depending on where and how they occur. The economic and "socioeconomic" effects, which can be expressed in dollars and numbers, are those most often recorded and reported. These include barrels of oil produced, jobs created, dividends paid, and the increased demands for community facilities such as schools, utilities, and recreational facilities.

Yet large-scale petroleum development can, and usually does, generate numerous other social "costs and benefits" which may be of equal or greater significance. These relate to community stability, feelings of personal well-being, the quality of intergroup relationships, the adequacy of community institutions, the availability of affordable housing, the extent of antisocial behavior, etc.

The range and degree of both the economic and other social effects (largely sociocultural and social psychological) appear to relate directly to certain factors of development. That is, as the conditions of development vary, so do the social and economic consequences.

Major Variables in Predicting Effects

1. The stage of oil and gas operations. Most geographic areas will experience only the preliminary exploration phase of petroleum activity. This phase ordinarily involves relatively few people, is short-term and --when properly supervised--produces few lasting effects for either humans or the environment.

In areas where a commercial-sized discovery occurs, successive stages of field development and production will require more workers and may continue for 20-40 years. Initially it will probably be more economically profitable for many people involved and more socially disruptive to affected communities.

2. The size of the discovery. Oil and gas production can involve a single well on an acre of land, or a large field of 100 or more wells occupying a township. The great majority of discoveries result in small fields or a few scattered wells, but when large fields occur, the effects are multiplied.

3. The capacity of the existing facilities and services (infrastructure) of the affected population centers. Two extreme examples are a large diversified community and a small farming community. Any stage of oil and gas activity would have much less impact on the larger city. Fewer employees would have to be "imported," subcontracting firms would be locally available, and there would already be sufficient housing, schools, stores, hospitals, and other needed facilities. Small towns, especially those under 2,000 population, seldom have adequate services even for their own residents, and usually are not well organized for systematic expansion.

4. The existing community orientation. Towns and cities vary significantly in their perceptions of mining, industrial development, appropriate land uses, desirable lifestyles, and in their receptiveness to change. For some, timber or ranching is a way of life that has been uninterrupted for generations. For others, mining or industrial activity is the norm and expansion is tolerated, even encouraged. Some people (the close-knit communities that follow a traditional agricultural lifestyle) are uncomfortable with such changes and this will be reflected in industrial values.

5. The pace of development. A specified amount of development can either be spread out over several years or completed within much less time with a "crash" program. Gradual development is often equated with progress, and, in many communities, it is welcomed by the majority of residents. Rapid development tends to overburden nearby communities and intensifies adverse effects. Figure 5 illustrates a typical development pattern.

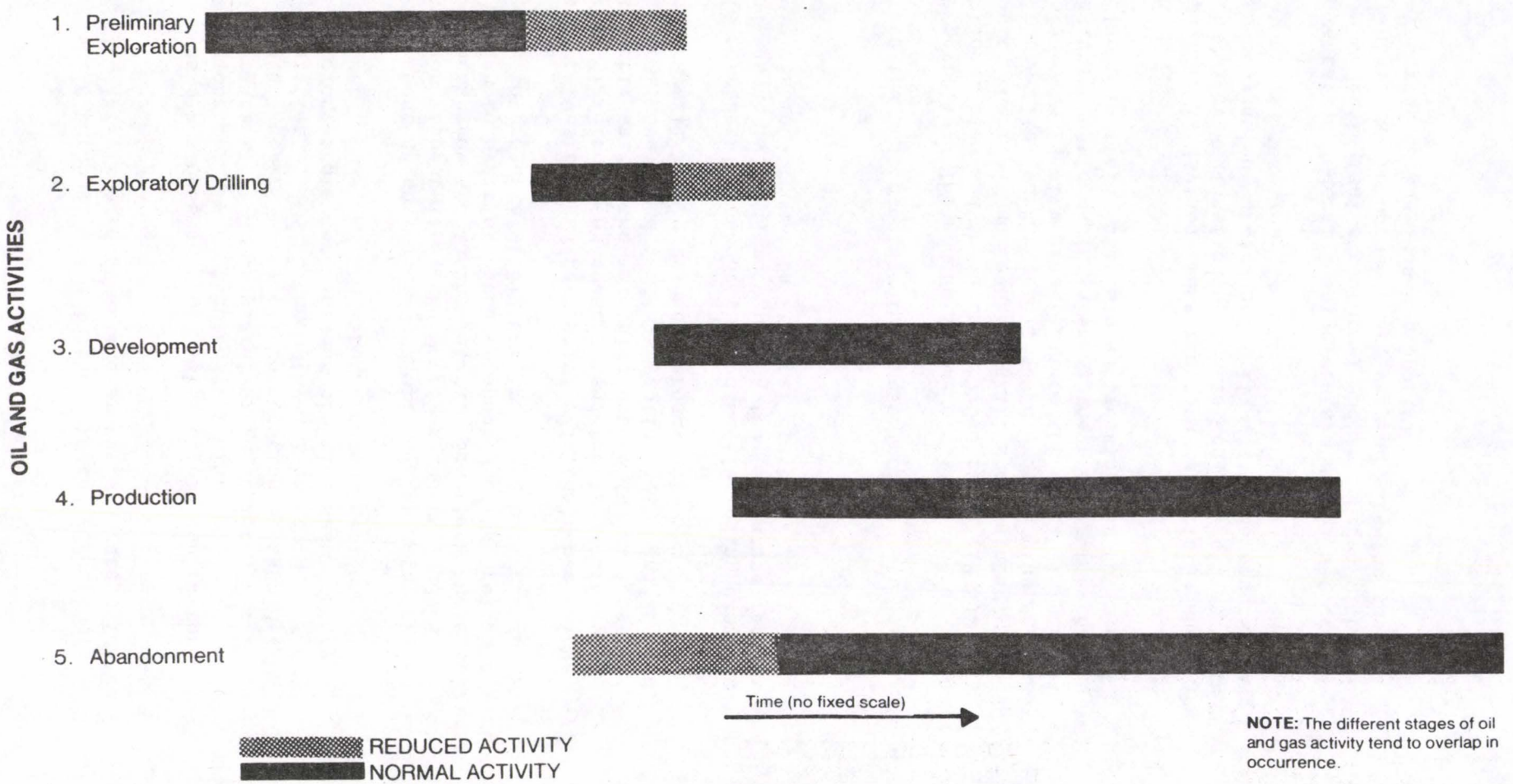
The situation is most critical when two or more companies initiate large-scale developments about the same time and fail to coordinate their activities with affected communities in order to reduce impacts.

6. Company policy and the choice of technology. Petroleum firms and their contractors differ substantially in their policies and practices. Some are more environmentally responsible and socially concerned than others. In some instances, equipment and procedures are selected to insure maximum compatibility with other resources. Social effects may also be monitored to minimize adverse impacts. A flexible company policy may permit some forms of assistance including jobs for local workers and various types of aid to communities attempting to meet growing demands for services.

In some cases, careful Forest Service supervision is required to insure compliance with sound environmental practices.

Figure 5

DURATION OF OIL AND GAS ACTIVITIES



NOTE: The different stages of oil and gas activity tend to overlap in occurrence.

7. An individual's personal stake in the expected effects of oil and gas activity. This is evident in the groups and categories to which one belongs:

rancher	small businessman	oil well or road contractor
parent	teacher	conservationist
hunter	forester	petroleum geologist
trucker	motel keeper	oil corporation stockholder
banker	motorist	unemployed laborer
car dealer	biology professor	member of Wilderness Society
	hiker	Western Montana resident

There are also clues about an outlook toward oil and gas activity in one's personal philosophy about life, the world around us, and our responsibility to others--now and in the future. Sometimes these convictions are strong enough to override concerns about profits, reliable fuel supplies, or a desire to preserve wildlife or maintain a virgin forest.

Thus, each person perceives oil and gas activity in their own unique way, and expects somewhat different consequences, and reacts accordingly. Some regard it favorably while others totally oppose it, at least for certain locations; some have mixed feelings, noting both benefits and problems; still others will simply be unconcerned.

It is now possible to generalize about the social (including economic) effects of oil and gas activities, recognizing that the above factors will produce many variations from this "typical" pattern.

Economic Effects

Economic effects are the most consistent. These include:

1. Employee payrolls. The median income of oil employees varies considerably with localities and is in the $15,000 range (1978). It varies even more with the type and level of skill and training, from as low as $10,000 for unskilled workers, to $25,000 or more plus expenses for skilled employees who usually transfer into the area. In general, the longer oil activity continues in an area, the greater the chances for local-hire jobs; i.e., in field maintenance, trucking, or any needed facilities.

Most of the oil payroll is divided among the towns and cities where the employees live, the major Regional shopping centers, the cities where the families of unaccompanied workers still live, and the several levels of Government that assess taxes.

2. Leasing rentals. Federal leasing rentals are $1 per acre annually ($2 in known geological structures) and are shared with the State. Private rentals may be much higher, varying with the assumed value of the oil reserves on the leased property.

3. Royalties to the landowner. As of January 1980, noncompetitive Federal oil and gas leases have a standard royalty obligation of 12-1/2 percent of production (with some exceptions for older leases operating under earlier agreements ranging downward to 5 percent). Competitive oil leases vary from 12-1/2 percent (on up to 110 barrels daily per well) to 25 percent (on volumes exceeding 400 barrels daily per well). Older leases may pay up to 33 percent. The royalty on highly productive gas leases (over 5 million cubic feet per well per day for a month) is 16-2/3 percent. See USDI-BLM circular 2357, latest edition, for details.

Half of this goes to the State (exception: only one-fourth if lands are acquired). In Montana the State's half is divided equally between the Department of Education and the Highway Department. Private royalties are negotiated on an individual contract basis and may even be higher.

4. Loans and grants available from Federal and State sources to assist counties or communities experiencing an influx of people following minerals or industrial development. Private sources may also be available. These are summarized in appendix D of Socioeconomic Assessment Guidelines for Oil and Gas Activities, Technical Draft. USDA-FS, Northern Region, April 1979.

5. Federal, State, and local tax revenues should eventually increase, including property, sales, corporate and private income, and excise taxes. Usually there is a 1- to 3-year time lag between the need for additional revenues and their availability. In Montana, affected communities can require firms to prepay property taxes for their large industrial developments that are currently under construction.

6. Equal opportunity stipulations on Federal leases and the generation of additional service occupations may increase employment opportunities for local women, minorities, and youths just entering the labor market.

7. Increases in nonbasic employment (also called induced, derived, or secondary employment). Economists believe that certain industries are basic to an area's economy because the bulk of their products are exported, bringing "new" money into the community or region. Examples might include a farmer exporting wheat, or a sawmill selling lumber to brokers in other States. Oil production is such a basic activity.

Much of the income from "exports" is spent locally, thereby supporting a number of additional businesses and services. These in turn employ more people, and a new round of spending is generated. The mathematical expression of the extent of total employment generated by basic industry is called an employment multiplier, which varies from about one to three, depending on how it is computed and whatever other factors may operate to exaggerate or counteract the effects of increases in certain basic industries. This means that, depending on circumstances, anywhere from none to two nonbasic jobs will normally be generated by each new basic employment opportunity.

Social Effects

Social and cultural effects are more difficult to quantify, but can be discussed in a narrative fashion.

We have already noted that preliminary exploration is the only phase of oil activity that most communities in the Northern Region will experience if they are outside of existing producing areas. This exploration phase, if moderate in scale and properly conducted, will normally produce few social impacts. Many communities in Beaverhead, Flathead, Powell, Granite, Lewis and Clark, and Pondera counties in Montana have experienced this activity during the past two field seasons.

Exploration involves relatively few personnel and, as noted in the scenario, they spend only a few weeks or months in any specific place. Most firms conduct field operations mainly during the warmer months when the areas of interest are most accessible, i.e., May to November, although a few try to operate year-round except during severe weather. Employees are often single or unaccompanied by dependents, reside in transient facilities, and eat in local restaurants and carry lunches into the field. Some live in campers or small mobile homes which are readily moved from one trailer park to another.

Exceptions to the usually low-key pattern of exploration occur when an area becomes "hot" following a significant discovery. Exploration activity will intensify as more companies send in field crews, and the risk of accidents and carelessness is likely to increase. The sounds of trucks, helicopters, and explosives become more evident, as will the increased pressure on motels, restaurants, bars, and other facilities.

Sometimes, to reduce these impacts and also cut costs, several oil firms initially pool resources, finance a single well-equipped exploration operation, and leave it to their own company geologists to interpret the results. Or an independent exploration firm may assess an area's potential and sell its findings to oil companies.

Well drilling requires additional specialized employees, most transferred from other areas, and a broader range of support services, often obtained locally. Because of their great expense, drilling rigs are often kept in operation around the clock and throughout the year, barring severe weather. Following a discovery, drilling crews may remain months to years in one area and additional personnel will be needed to construct site facilities, to build roads and gathering pipelines, and to operate and repair equipment. It is at this stage that social impacts will become more evident. Not only will dozens to hundreds of new employes be required, but the greater permanence of their jobs will encourage incoming workers to bring their families with them.

Population growth rate is probably the most critical variable. In the Northern Region, a community's annual growth rate is usually under 2 percent, requiring 40 years or more to double. Then comes development. A 7 percent increase would double the population in a decade; 15 percent annually would double in just 5 years, greatly reducing the time available for adapting facilities, expanding revenues, building homes, extending services, and adjusting traditions and attitudes.

As Gilmore 12/ and others have documented in community case studies, truly large-scale mineral development, whether a single large operation or a combination of smaller undertakings, can overwhelm a community, especially when there has been no coordinated effort to anticipate and meet the challenges of rapid growth. As a result of a combination of mining, oil activity, and hydroelectric power development, Rock Springs, Wyoming, grew from 18,391 to 36,910 in the 1970-74 period alone, an average of 19 percent annually. The result, reports Gilmore, was:

1. A deterioration in the quality of life as population outran the community's capacity to provide facilities and services, and newcomers were not adequately integrated while older residents were disadvantaged in several ways.

2. Industrial productivity declined 25-40 percent due to labor shortages and rapid employee turnover as distressed newcomers left the area.

3. Both private investment in new commercial facilities and services and public revenues lagged significantly behind population growth and consumer requirements.

Social problems are a normal aspect of life in any community. There are always conditions or situations that distress some segment of the population. Many such problems occur when groups differ in their judgment of what is more important or desirable among the many options available. A proposed change in community life may be welcomed by some of the residents and staunchly opposed by others. This may result in serious cleavages. Alternately, some very stable communities are the result of an acceptable compromise between those who promote change and others who favor traditional approaches, each making some concessions to achieve harmony.

The central problem posed for humans by energy development is that social change may occur so rapidly that it exceeds our individual or collective capacity to deal with it. We need time to identify needs, design strategies for meeting them, find the necessary money or other resources, expand facilities, etc. Table 6 shows the relationship of growth rate to the quality of community life.

12/ Gilmore, John S., Boom Town Growth Management. Boulder, Colo.: Westview Press, 1975.

Table 6--Three rates of population growth and their implications for community life

Level of change	Average annual rate	Characteristic implications	Major variables which intensify or reduce the problems
Manageable growth	About 1-5%	Most difficulties can be resolved as they occur	Are there other local communities to share the population influx?
		Some additional jobs available	
		With adaptations, growth consistent with community resources	Is the community large enough to offer a wide range of services?
		Moderate growth may be equated with progress, be a source of pride.	Are there knowledgeable persons to assume leadership roles?
Problem-sector growth	About 6-10%	Some sectors unable to cope with growth and services lag; e.g., utilities, hospitals, or schools	Do existing community services have excess capacity, perhaps due to previous population loss or overbuilding?
		Revenues insufficient to meet the need for additional facilities and services	Are there supplementary revenues from county, State, corporate, or Federal sources?
		Haphazard commercial development occurs	Is there effective planning and zoning?
		Housing shortages may become severe	Is city government energetic and effective?
		Erosion of traditions, informal social controls, and patterns of mutual aid	The success of the community in integrating newcomers

Table 6--Three rates of population growth and their implications for community life (cont'd)

Level of change	Average annual rate	Characteristic implications	Major variables which intensify or reduce the problems
Boomtown growth	11% or more	Multiple problems in most community sectors	Is there an integrated planning team, seriously committed, and consisting of representatives from major governmental and private organizations involved?
		Large-scale immigration of workers; may exceed demand for labor	
		Obvious breakdown in effectiveness of both public and private institutions	Is "front end" (advance) income available for meeting community needs?
		Growing public distress and alienation	Is the activity of long duration justifying permanent expansion of facilities and services?
		Worker absenteeism and turnover	
		Increased incidence of social problems; e.g., traffic congestion, crime, delinquency, child abuse, broken homes, mental illness, etc.	Are land, water, and other necessary resources readily available to permit orderly growth?
		Inflation of rentals, goods, services	
		Changing personal orientations affect many long-standing friendships	Is the community accustomed to a significant level of growth and population turnover?
		Cleavages exist between newcomers and older residents	

PUBLIC CONCERNS AND FOREST SERVICE RESPONSE

Increasingly, a major aspect of social impact is the scope and intensity of public support and/or opposition to a proposed Forest activity. Various individuals and organized groups will come forward and express their views at public meetings, in personal visits, or in correspondence. These persons or groups may base their preferences on objective criteria or sometimes use inaccurate data. They may be personally disadvantaged, expect to benefit, or have nothing involved but their sense of propriety. In either case, they have been affected by the proposed action.

As the Forest Service organization makes ever-greater efforts to involve the public in decisionmaking, and as more people join special interest groups to achieve their goals, this type of impact becomes more critical. The Forest Service must seek policies which meet National direction, yet attempt to satisfy both pro- and anti-development sectors of the public. Often this is impossible, and considerable compromise is necessary. Study teams attempt to assess all important dimensions of a problem and derive a sound course of action.

Such is the case with oil and gas leasing. Leasing itself is a relatively innocuous process, but the potential for subsequent environmental and human effects is great in the few instances when a sizable discovery results. Eventually, most leasing will be handled in routine land management planning, in the same manner as any other resource management activity.

When current plans inadequately provide for leasing and subsequent oil and gas activities, an interdisciplinary team of Forest personnel will do an environmental analysis. If the anticipated physical, biological, economic, and social effects are determined to be minor, the analysis is documented in an environmental assessment with a "finding of no significant impact," and the proposed activity may proceed with appropriate lease stipulations and Forest Service supervision to protect other resources.

If it is determined that the proposed oil and gas activity may have consequences for humans that are significant, the environmental analysis made by the interdisciplinary team is documented in an environmental impact statement (EIS) which assists the responsible officials in defining and implementing Forest Service policy.

SUMMARY

Recent international events have focused public attention on growing U.S. dependence on imported oil. There is increased interest in both conservation and the location of additional domestic sources. The environmental movement has increased public awareness of the importance of a quality environment and protective legislation has resulted. The challenge before us is to meet our energy needs without unduly jeopardizing other resource values. The process of analyzing the social and environmental effects of different Forest Service alternatives is our approach to this problem. It provides opportunity for public involvement and a documented analysis and decision process.